Prevention of Significant Deterioration Air Dispersion Modeling Protocol

600-MW Coal-Fired Boiler
Big Stone II
Otter Tail Corporation

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1.0 INTRODUCTION

Otter Tail Corporation (Otter Tail) is proposing to construct a new 600+ megawatt (MW) [net] pulverized coal (PC) fired boiler at the existing Big Stone Power Plant near Milbank, South Dakota. Potential emissions indicate that the proposed construction will be a major addition at an existing major source, subject to a Prevention of Significant Deterioration (PSD) construction permit review. Since a PSD permit requires an assessment of ambient impacts for those pollutants subject to PSD review, this document presents an air dispersion modeling protocol to be used in developing the PSD application. Submittal of this protocol will allow the South Dakota Department of Environment and Natural Resources (DENR) to review and comment upon the methodology to be employed in the modeling analysis.

Included in this document is a brief description of the project, proposed model to be used, and input parameters for the proposed model. This modeling protocol has been drafted in accordance with USEPA modeling guidelines.

2.0 PROJECT DESCRIPTION

Otter Tail is proposing to build one new coal-fired boiler at its existing site at Big Stone Power Plant near Milbank, South Dakota.

The boiler will have a nameplate heat input capacity greater than 250 million Btu per hour and, according to the PSD regulations, will be classified as a named installation according to 40 CFR 52.21. Therefore it is subject to PSD review if emissions of any pollutant exceed 100 tons per year (tpy). The coal-fired boiler will trigger PSD review since the emissions of multiple pollutants are expected to exceed their respective *de minimis* levels.

3.0 PROPOSED MODEL

Otter Tail is proposing to use the Industrial Source Complex Short-Term (ISCST3) model (version 02035 or newer) for the air quality analysis. The ISCST3 model is an EPA-approved, steady state Gaussian plume model capable of modeling multiple sources in simple and complex terrain. ISCST3 is the model used for most industrial sources and PSD permits and is an appropriate model for these types of sources.

The following default model options will be used:

- Final Plume Rise
- Stack-tip Downwash
- Buoyancy-induced Dispersion
- Calms Processing
- No Use of Missing Data Processing Routine
- Default Wind Profile Exponents
- Default Vertical Potential Temperature Gradient
- Rural Dispersion

Details of the modeling algorithms contained in the ISCST3 model may be found in the User's Guide for ISCST3. The regulatory default option will be selected for this analysis since this project meets the USEPA guideline requirements.

4.0 MODELING PARAMETERS

Since it is expected that PSD review will be triggered, all pollutants regulated under 40 CFR Part 52.21 that are emitted in a significant quantity will require an air quality analysis. According to preliminary calculations, NO_X, SO_2, CO, and PM_{10} are expected to be subject to PSD review, and an air quality analysis will be performed for them. Since VOCs are photoreactive pollutants and are generally regional in nature in terms of their contribution to ozone formation, no reactive-pollutant modeling of VOCs is proposed at this point. In addition, Otter Tail requests that a pre-construction ambient ozone monitoring study not be required since potential VOC emissions are expected to be less than 100 tpy.

To determine the facility's significant impact area (SIA), emissions from the proposed source will be modeled alone, that is, without other sources in the area. The initial step in defining the SIA will be to model the boiler at 100, 75, 50, and 25 percent capacity for each pollutant to determine the operating capacity that results in the worst-case ambient impact. The capacity analysis will be performed using the 5-year meteorological data set of 1999 through 2004. Once the worst-case capacity is identified, the boiler will be modeled to determine the SIA. The SIA is determined to be the distance from the proposed fence line that any pollutant concentration exceeds its PSD modeling significance level (MSL). Each load case will be analyzed using the five years of meteorological data, and the significant impact areas for each averaging period will be determined. From this data, if the modeling results indicate that a pollutant does exceed the PSD MSL for any averaging period, the maximum distance from the property line that the pollutant concentration exceeds the MSL will be determined. This distance will then be increased by 50 kilometers (km), in accordance with the 1990 Draft New Source Review Guidance (known as the radius of impact [ROI]). The ROI will then be identified and submitted to the DENR for refined modeling purposes.

4.1 Emission Rates

These emission rates represent operations at worst-case ambient conditions under various operating capacities, respectively. The ISCST3 model will give the ambient ground-level impact results for all pollutants, including NO_X. However, impacts of NO_2 must be examined for comparison to NAAQS, PSD increments and significance values. Therefore, the resulting concentrations of NO_X will be screened using the EPA approved Ambient Ratio Method (ARM). Tier 2 of the ARM allows the use of an empirically derived NO_2/NO_X ratio of 0.75, which means that approximately 75 percent of the NO_X emissions will be converted to NO_2, the regulated pollutant. This factor will be applied to the modeled results for NO_X to determine the predicted ground level concentration of NO_2.

4.2 Good Engineering Practice Stack Height

Sources included in a PSD permit application are subject to Good Engineering Practice (GEP) stack height requirements outlined in 40 CFR Part 51, Sections 51.100 and 51.118. As defined by the regulations, GEP height is calculated as the greater of 65 meters (measured from the ground level elevation at the base of the stack) or the height resulting from the following formula:

$$GEP = H + 1.5L$$

Where,

H = the building height; and

L = the lesser of the building height or the greatest crosswind distance of the building - also known as maximum projected width.

To meet stack height requirements, the proposed point sources will be evaluated in terms of their proximity to nearby structures. The purpose of this evaluation is to determine if the discharge from each stack will become caught in the turbulent wake of a building or other structure, resulting in downwash of the plume. Downwash of the plume can result in elevated ground-level concentrations. EPA provides guidance for determining whether building downwash will occur in *Guideline for Determination of Good Engineering Practice Stack Height* (EPA, 1985). The downwash analysis will be performed consistent with the methods prescribed in this guidance document. The generation facility and associated point sources will be evaluated in terms of their proximity to nearby structures.

Calculations for determining the direction-specific downwash parameters will be performed using EPA's Building Profile Input Program, otherwise referred to as the BPIP downwash algorithm, Version 95086.

4.3 Emission Source Parameters

In addition to point sources, fugitive sources, such as haul roads and storage piles, will also be examined for determining compliance with the air quality standards. For the purposes of the air dispersion modeling analysis, it was determined that volume sources will be used to represent the emissions from haul roads and any open conveyor drop points. Area sources will be used to represent fugitive emissions from the coal storage piles and the landfill.

As the parameters for volume sources are defined in the ISCST3 user manual, haul roads are assumed to be 30 feet (9.144 m) wide; therefore a 30 foot by 30 foot volume source can be assumed. This allows the haul road to be broken up into segments aligned in 30-foot by 30-foot segments. The ISCST3 Model allows the user to either have haul roads situated directly next to each other (exact representation) or with a space between them the size of one volume source (approximate representation). The approximate representation will be used for these runs to minimize the number of sources and decrease computational time. A 30-foot (9.144 m) road width corresponds to an initial lateral dimension of 8.51 m (2 · 9.144 m ÷ 2.15m). It is assumed that the scrapers or mine trucks hauling the fly ash are 10 feet (3.048 m) high, making the initial vertical dimension 1.42 m (3.048 m ÷ 2.15). The release height will correspond to approximately the top of the wheel (1.5 m for mine trucks or scrapers). This approach is conservative since the top of the wheel is higher than 1.5 m.

The coal loadout onto the active storage pile (essentially an open conveyor drop point) will be modeled as a volume source with a lateral dimension of 0.28 meters, a vertical dimension of 0.93 meters and a release height of 2.0 meters.[1] For the area sources, the dimensions of each pile will approximate the area that each of the piles covers. Fugitive emissions from these sources will be estimated from the AP-42 section on industrial wind erosion.[2]

Both the point and volume sources will be modeled to correspond to the boiler operating at 100 percent capacity. During the runs where the boiler will be operating at 75, 50, or 25 percent capacity, the fugitive emission sources will remain at emission levels corresponding to 100 percent unit load. While this

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[1] Based on actual conveyor dimensions and calculation methods listed in Table 1-6 of *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II.*
[2] AP-42 Section 13.2.5, *Industrial Wind Erosion* (1/95 Update).

method does not accurately reflect the operations at the facility, the results of the model will yield a worst-case impact scenario.

5.0 MODELING METHODOLOGY

5.1 Receptor Grid

The overall purpose of the modeling analysis is to ensure that operation of the proposed facility will not result in, or contribute to concentrations above the National Ambient Air Quality Standards (NAAQS) or PSD Class II increments. The modeling runs will be conducted using the ISCST3 model in simple terrain within a Cartesian grid to determine the significant impact area for each pollutant. The grid will incorporate the following spacing between receptors: 100-meter out to 1 kilometer, 500-meter out to 5 kilometers, and 1,000-meter out to 50 kilometers. If the significant impact area exceeds 50 kilometers the grid will be extended to encompass the entire significant impact area. If the modeling impacts show "hot spots" outside 1,000 meters, 100-meter grid spacing will be used to encompass the maximum concentrations to ensure that the maximum impact has been identified. Receptors will also be placed along the property boundary at a spacing of 50 meters. After reviewing the topography of the area, it was determined that terrain elevations should be incorporated into the model. Therefore, the appropriate USGS 7.5 minute topographical maps (from electronic DEM data) will be used to obtain the necessary receptor elevations.

5.2 Meteorological Data

Surface air meteorological data from Huron with Aberdeen upper air data from 1999-2004 will be used in the analysis.

5.3 Model Parameters

Based on the Auer scheme, the existing land use for a three-kilometer area surrounding the proposed site is more than 50 percent rural. Also, the population density is less than 750 people/km^2 for the same area. Therefore, rural dispersion coefficients will be used in the ISCST3 Model.

The ISCST3 program cannot model impacts that occur within the cavity regions of building downwash. To compensate for this deficiency, the SCREEN3 modeling program will be run (version 96043). SCREEN3 will only be used to calculate the impact from point sources within cavity regions of buildings. Otter Tail proposes to run the SCREEN3 model for each point source using a 1 g/s emission rate. Predicted concentrations will then be scaled to the source-specific maximum emission rate. If these concentrations occur within the fenceline of the proposed site, further analysis will not be required. Since the SCREEN3 model generates 1-hour concentrations, the approved EPA conversion factors shown in Table 1 will be used to compute concentrations for longer averaging periods.

Table 1: SCREEN3 Conversion Factors

Averaging Time	Conversion Factor
3-hour	0.9
8-hour	0.7
24-hour	0.4
Annual	0.08

5.4 Significant Impact Area Determination

The ISCST3 Model will be run for the proposed facility using the worst-case capacity scenario for the coal-fired boiler. If any modeled pollutant results in an impact below the significance levels for each averaging period, no further modeling for that pollutant to determine compliance with the NAAQS or PSD Class II increments is needed. However, if the model predicts impacts at or above the MSL for any pollutant, a cumulative analysis including all point sources within the ROI will be required for that pollutant. Depending on the initial modeling results, Otter Tail will request from DENR an emission inventory of PSD increment-consuming sources and NAAQS sources that are located within the ROI and should be included in the modeling analyses.

5.5 NAAQS and Class II Increment Analysis

For the NAAQS and PSD increment analysis, all major stationary sources that emit pollutants subject to this analysis and located within 50 kilometers of the ROI will be addressed. A source within 50 kilometers of the impact area may be eliminated from the analysis if it is determined to have a negligible contribution to air quality impacts at the generating station. Otter Tail will consult with DENR to determine acceptable methods of eliminating sources from the analysis. Background air quality values will be provided by the DENR to add to model-predicted concentrations for comparison to the NAAQS. If the refined analysis does not result in any concentrations above the NAAQS or PSD increments, no further modeling will be conducted.

5.6 Ambient Monitoring

The modeling analysis for emission sources at the proposed Otter Tail facility will also address the pre-construction monitoring provision of the PSD regulations. The regulations specify significant monitoring *de minimis* levels for each PSD pollutant that triggers the requirement to perform one year of pre-construction ambient air monitoring. For any impacts predicted to be below the monitoring *de minimis* levels, Otter Tail will request an exemption from pre-construction ambient air monitoring. If any predicted concentration reaching or exceeding the monitoring *de minimis* levels are observed, Otter Tail will consult with the DENR to determine the adequacy the historical pre-construction ambient air monitoring. Table 2 shows the NAAQS, modeling/monitoring significance levels, and PSD increments.[3]

Table 2: NAAQS, Significance Levels and Class II Increments ($\mu g/m^3$)

Pollutant	Averaging Period	NAAQS	Modeling Significance Level	Monitoring Significance Level	PSD Class II Increment
TSP	24-hour	150 (state standard)	--	--	--
NO_X	annual	100	1	14	25
CO	8-hour	10,000	500	575	NA
	1-hour	40,000	2,000	NA	NA
PM_{10}	annual	50	1	NA	17
	24-hour	150	5	10	30
SO_2	annual	80	1	NA	20
	24-hour	365	5	13	91
	3-hour	1,300*	25	NA	512

* Secondary standard.

6.0 CLASS I AREA IMPACTS

PSD regulations require that a proposed major source perform an assessment of air quality impacts at Class I areas if these areas are located within 300 km of the proposed facility. Recent Federal Land Manager (FLM) guidance indicates that all Class I areas within 300 km should be reviewed in the course of a PSD application. There are no Class I areas within 300 km of the Big Stone Power Plant. Typically, proposed facilities over 300 km from a Class I area are not a threat to visibility impairment.

7.0 SUMMARY

Otter Tail would like to proceed with the initial modeling analysis as soon as possible in order to ensure that a pre-construction ambient air monitoring study will not be required. Also, if emission inventories and background air quality data are needed from DENR and other agencies to complete refined modeling analyses, initial modeling to determine the ROI for each pollutant should be expedited to give DENR enough time to process these requests.

[3] The pollutants that are allowed one NAAQS exceedance per year and one PSD Increment exceedance per year are: 1-hour and 8-hour CO; 3-hour and 24-hour SO_2; and 24-hour PM/PM_{10}.